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CRYOGENIC TREATMENT OF BEAVERS DENTAL BURRS

K.C. WANG

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CRYOGENIC TREATMENT OF BEAVERS DENTAL BURRS

by

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ABSTRACT

Beaver Dental burrs made of 3% Ni, 3% Fe, 3% Co and 91% WC were cryogenically treated to improve the cutting ability. The performance in cutting glass improves by 0.5 to 11.8% depending on the treatment. The performance in cutting brass scatters widely, and no conclusion can be drawn statistically.

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LABORATOIRES DE LA TECHNOLOGIE DES MÉTAUX
RAPPORT MTL 91-42(TR)

TRAITEMENT CRYOGÉNIQUE DES FRAISES DE LA SOCIÉTÉ BEAVER DENTAL

par

K.C. Wang

RÉSUMÉ

Des fraises de la Beaver Dental composées de Ni (3 %), fe Fe (3 %), de Co (3 %) et de WC (91 %) ont été traitées cryogéniquement dans le but d'en améliorer la capacité de coupe. On constaté une amélioration de leur performance de 0,5 % à 11,8 %, selon le traitement effectué. Leur capacité de couper le laiton varie toutefois considérablement; aucune conclusion ne peut être tirée statisfiquement.

INTRODUCTION

Beavers Dental of Morrisburg, Ontario has manufactured dental burrs with 6% Co WC for years. This grade of carbides provides suitable hardness and cutting ability. Robert Sachs of Beavers Dental developed a 3-3-3 alloy, i.e., 3% Co, 3% Ni, 3% Fe and 91% WC. However this 3-3-3 alloy was found to have average cutting ability. A remedial method, coating with TiC, was tried without success. With this information in hand and some claims that cryogenic treatment may improve the wear resistance of tool steels and carbides, but without solid evidence, an exploratory investigation was carried out with further application for carbide tools in the resource industry in mind.

EXPERIMENTS AND RESULTS

A bag of 200 #557 burrs from Lot No.9440 was received from Beavers Dental. One hundred 1.65 mm dia x 5 mm deep holes were drilled in a 101 mm dia x 21 mm thick aluminum block. The steel shanks of 1.59 mm dia burrs were inserted into the holes so that the carbide tips pointed upwards. The burrs were cooled slowly with liquid nitrogen vapour, then mist, and eventually completely immersed in liquid nitrogen. This process took about 1 h. They were held in liquid nitrogen for two hours then slowly warmed up to room temperature in 14 h. Some of the burrs were further tempered at 100°C, 150°C, underwent a second cryogenic treatment, and were then tempered as shown in Table 1. The treated burrs were bagged separately, coded and tested at Beavers Dental.

At Beavers Dental there are two standard cutting tests. A brass test (the time to cut a certain distance into a brass sheet with the side of the burr) and a glass test (the total depth of five cuts with one burr each in a certain time into the glass with the burr inclined a shallow angle to the glass). The acceptance level for the brass test is 10 s and for the glass test is 0.080 inch.

RESULTS AND DISCUSSION

The results and the statistical analyses are shown in Tables 2 and 3. Specimens F and A both showed improvement in the brass cut and glass cut tests. In the glass cut test, the results of Specimen A is only significant at the 20% level. Treatments C1, D, E, F and G are all significantly different from the as-received specimens. In the brass cut test, the results are so scattered that, statistically, none of the treatments are significantly different from the as-received Sample I, even for the most improved treatment F.

In combining the results from both glass and brass cutting tests, Treatment F, i.e., double cryogenic treatment with 150°C temper has the best over-all improvement. With this

treatment, all samples passed the 0.080 in. acceptance requirement and showed an 11.8% improvement in the glass cutting test and a 22.9% improvement in the brass cutting test even though the results are not statistically significant and more samples are required.

CONCLUSIONS

1. Cryogenic treatment is effective in improving the glass cutting ability, i.e., in cutting hard, abrasive material. In the present case, a double cryogenic treatment followed by a 150°C temper improved the performance by 12%.

2. The results of the brass cutting test are so scattered that the effect of cryogenic treatment cannot be statistically determined with 10 samples in each group. A larger sample population is required.

Table 1. Cryogenic treatment of dental burrs.

	A1	B1	C1	D	E	F	G	H	I as-received
Cryo T	*	*	*	*	*	*	*	*	
100°C temp		*					*		
150°C temp			*					*	
2nd cryo T				*	*	*	*	*	
100°C temp					*				
150°C temp						*			

Table 2 Glass cutting test of dental burrs. Depth of cut in glass 0.001 in.

	A1	B1	C1	D	E	F	G	H	I
	78.5	81.0	76.0	88.5	81.5	81.0	77.5	77.0	72.5
	82.5	76.5	78.5	80.0	82.5	98.0	96.0	68.5	81.0
	85.0	71.0	82.5	74.0	81.0	84.0	80.5	82.0	69.5
	90.5	82.0	86.5	83.5	80.5	87.5	78.5	78.5	70.0
	81.0	73.5	86.0	87.0	86.5	90.0	86.0	91.5	85.0
	93.5	82.0	81.0	90.5	89.0	87.0	88.0	76.0	77.5
	76.0	72.5	83.0	88.5	84.0	83.5	93.0	69.0	78.0
	72.5	82.5	71.0	86.0	80.5	84.0	74.5	85.5	80.5
	75.0	87.5	128.0	86.5	84.5	86.5	106.0	75.5	86.0
	85.5	73.0	100.0	90.0	87.0	87.5	83.5	100.5	77.5
Maximum	93.5	87.5	128.0	90.5	89.0	98.0	106.0	100.5	86.0
Minimum	72.5	71.0	71.0	74.0	80.5	81.0	74.5	68.5	69.5
Average	82.0	78.2	87.3	85.5	83.7	86.9	86.4	80.4	77.8
% Improvement	5.5	0.5	12.2	9.9	7.7	11.8	11.1	3.4	0.0
Σx_i	820	782	873	855	837	869	864	804	778
Σx_i^2	67 655	61 352	78 498	73 250	70 139	75 713	75 412	65 528	60 745
Si^2	46.1	30.9	263.6	25.9	9.1	21.9	94.3	98.4	32.7
S^2	39.4	31.8	148.2	29.3	20.9	27.3	63.5	65.6	32.7
t	1.496	0.139	1.736	3.159	2.886	3.894	2.399	0.718	0.020
p	20%	-	10%	1%	1%	0.2%	5%	-	-

Remarks:

1. $\Sigma x_i = \Sigma AI, \Sigma BI, ..., \Sigma I$
2. $\Sigma x_i^2 = \Sigma AI^2, \Sigma BI^2, ..., \Sigma I^2$
3. $Si^2 = [\Sigma x_i^2 - (\Sigma x_i)^2 / 10] / (10 - 1)$
4. $S^2 = (S_i^2 + S_I^2) / 2$
5. $t = (\bar{X} - \bar{X}_I) / S(1/10 + 1/10)^{1/2}$ in Student t distribution
6. p = probability of samples being similar to the as-received Sample I

Table 3. Brass cutting test of dental burrs. Time taken to cut brass (s).

	A1	B1	C1	D	E	F	G	H	I
	1.53	1.67	2.26	1.87	2.12	2.89	1.27	4.01	1.90
	2.32	2.84	1.79	1.82	1.39	0.93	1.82	3.81	0.69
	1.09	3.06	1.98	9.56	5.93	1.93	1.47	1.32	2.40
	1.51	3.06	2.33	7.07	2.15	1.37	1.55	2.15	3.72
	1.72	2.42	1.98	2.76	2.28	0.63	2.77	2.06	1.56
	1.17	0.95	3.16	2.30	1.46	0.79	1.90	4.02	1.78
	2.15	2.83	2.03	2.35	1.06	1.19	1.78	4.65	1.20
	1.88	3.21	5.70	2.86	0.77	2.55	2.50	2.10	0.87
	2.43	0.83	1.92	1.44	1.80	1.83	1.11	11.51	2.54
	1.39	1.25	1.64	1.58	0.78	1.39	7.19	0.95	3.43
Maximum	2.43	3.21	5.70	9.56	5.93	2.89	7.19	11.51	3.72
Minimum	1.09	0.83	1.64	1.44	0.77	0.63	1.11	0.95	0.69
Average	1.72	2.21	2.48	3.36	1.97	1.55	2.34	3.66	2.01
% Improvement	14.5	-10.0	-23.3	-67.2	1.8	22.9	-16.2	-82.0	0.0
Σx_i	17.19	22.12	24.79	33.61	19.74	15.50	23.36	36.58	20.09
Σx_i^2						29.03			49.69
Si^2						0.56			1.04
S^2						0.798			1.038
t						1.151			0.002